NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

DEFENSE SPENDING AND REGIONAL GROWTH: AN EXAMINATION OF AN EXPORT-BASE MODEL AND AN ECONOMETRIC MODEL

by

Brian G. Finch

June 1987

Thesis Co-Advisors: Loren M. Solnick
Stephen L. Mehay

Approved for public release; distribution is unlimited.

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b DECLASSIFICATION / DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b OFFICE SYMBOL (If applicable) Code 54	7a NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000	7b ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000
8a NAME OF FUNDING / SPONSORING ORGANIZATION 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification)
DEFENSE SPENDING AND REGIONAL GROWTH: AN EXAMINATION OF AN EXPORT-BASE MODEL AND AN ECONOMETRIC MODEL

12 PERSONAL AUTHOR(S)
Finch, Brian G.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year Month Day)	15 PAGE COUNT
Master's Thesis	FROM ____ TO ____	1987 June	62

16 SUPPLEMENTARY NOTATION

17 COSATI CODES		
FIELD	GROUP	SUB GROUP

18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Defense Spending, Regional Growth, Export-Base Model, Econometric Model

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

This thesis concerns the relationship between defense expenditures and the states' economic growth since 1975. The chief emphasis is on analysis of both an export-base model and an econometric analysis of the relationship between defense spending and personal income. Also considered are the effects of manufacturing wage rates, state tax rates, population and elements of state, and federal expenditures on personal income.

20 DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL Professor Loren M. Solnick	22b TELEPHONE (Include Area Code) 408-646-2249 22c OFFICE SYMBOL Code 54 Sb

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

Defense Spending and Regional Growth: An Examination of An Export-Base Model and an Econometric Model

by

Brian G. Finch
Lieutenant, United States Naval Reserve
B.S., Auburn University, 1979

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 1987

ABSTRACT

This thesis concerns the relationship between defense expenditures and the states' economic growth since 1975. The chief emphasis is on an analysis of both an export-base model and an econometric analysis of the relationship between defense spending and personal income. Also considered are the effects of manufacturing wage rates, state tax rates, population, and elements of state and federal expenditures on personal income.

TABLE OF CONTENTS

LIST OF TABLES

I. INTRODUCTION

A. DEFENSE SPENDING AND GROWTH

During the past decade, total defense expenditures have increased in relation to the total of all federal expenditures. Many factors have played a role in this dramatic rise in the importance of defense spending. Two major factors in these increases have been the technical complexity of military hardware and software and the ever-increasing role of the U.S. military in response to the increased dominance of the Soviet Union in the world political arena.

The total amount of resources that are owned by the military are immense. In 1974, the Department of Defense owned $172 billion in supplies, equipment, and weapons. The Department of Defense also had $51 billion in physical assets, land, and buildings. These property holdings were comprised of 16 million acres of public domain land owned outright by DOD in 22 states and an additional 375,000 acres of leased land in 48 states. The inventory of capital equipment owned by DOD is three times larger than all of the other federal departments and agencies combined, and the land holdings are two times as large. [Ref. 1:26]

The majority of federal purchases from the private sector is for military programs. These military purchases require a specialized industrial base which is significantly different from that required by the civilian economy. The military industrial requirements utilize

approximately one-fifteenth of the nation's labor force and total output [Ref. 1:26]. These specialized industries have only a few relatively large manufacturers which provide most of the military's needs. Due to the size of the defense procurement dollar, the industries and the regions in which these industries are located have shown a disproportionate share of economic growth.

The direct effects of defense spending are easily quantifiable. The number of employees, their wages and salaries, and the profits to companies as a direct result of military spending are relatively easy to measure. It is the other, more subtle effects which are more difficult to measure. Industries such as construction, food, clothing, textiles, lumber, furniture, machinery, wholesale and retail trade, and those in the service sector are indirectly affected by the flow of defense dollars. The variations of their dependency on the defense dollar comprise a major factor in the deterination of a region's growth.

A study of the simple by-state statistics of the elements of defense spending, such as procurement dollars, military wages and salaries, and DOD civilian wages and salaries, does not provide an adequate base to judge the true impact of defense spending in a given area. The portion of government spending solely directed for military purposes is not sufficient to judge the growth effects. Other, less-quantifiable "ripple effects" of personal income growth in the industries not directly affected by military, and the effects of governmental outlays to improve the health and education and transportation systems, must

also be examined if any model is to reflect the true nature of the effects of defense spending on the economic growth of a state.

B. ORGANIZATION OF THE STUDY

This study will utilize two methods of analysis to determine the impact of defense spending on regional growth. The first method, first proposed by Roger Bolton in his work Defense Purchases and Regional Growth (1966), will examine the effects of defense spending on the interstate export industries in each state from 1975 until 1985. The second model will provide a statistical analysis of the relationship between state economic growth and federal, state, and local government expenditures. The purpose will be to isolate and measure the impact of defense expenditures on state growth rates.

In Chapter II, a simplified version of Bolton's export-based model is examined for a 10-year period beginning in 1975. Chapter III examines the methodology of regional econometric modeling. Chapter IV is devoted to a statistical analysis of the variables comprising the determinants of state growth. It also discusses the statistical results and problems encountered.

In summary, this study will examine defense spending effects in a historical context and will provide a basis for further study of the factors which can assist in the determination and prediction of defense spending effects on the states' economic growth.

II. A SIMPLE EXPORT-BASED MODEL OF STATE GROWTH AND THE IMPACT OF DEFENSE SPENDING ON THE EXPORT SECTOR

A. INTRODUCTION TO THE EXPORT-BASED MODEL

The export-based model is based upon the theory that the regional growth rate is a function of regional export performance. The levels of these exports can be considered as manufacturing outflows and inflows based on production or on a personal income basis, which is derived from an analysis of income flows into and out of the state or region. In this portion of the study, an analysis of personal income flows is utilized to examine the nature of the export sector in each state and to examine the impact of defense spending on the export sectors on each state's economy. The methodology of this portion of the study was adapted and simplified from an export-based model of defense spending and regional growth by Roger Bolton [Ref. 2].

Regional statistics for the United States are not based on "regional gross products" or "regional incomes at factor costs." [Ref. 3:503) However, there is an excellent source of regional personal income statistics. These statistics are compiled annually by the Bureau of Economic Analysis (BEA), U.S. Department of Commerce. The BEA provides estimates of personal income derived from all sources by two-digit Standard Industry Code from 1969 through 1985. The definitions of the state accounts are basically the same as those underlying the personal estimates in the national income and product accounts provided by the U.S. Department of Commerce in the publication

Survey of Current Business. It is for that reason that personal income was adopted as the measure of state growth for this portion of the analysis [Ref. 3:505].

Personal income in each state can be considered as coming from two sources, either exogenous or endogenous. The exogenous incomes are considered to have been derived from sources outside the state or region. An example of an exogenous income source could be found in an examination of a state that has a large lumber or mining industry. Raw materials and finished goods such as lumber or metals are largely shipped outside of the state for sale. The sales dollars are returned to the state and converted into personal income for the employees and owners of these firms.

Endogenous incomes are considered to have been derived from sources exclusively within the state or region. Such incomes are usually found in the service sector, and in industries such as retail trade and construction, which provide goods and services to the local markets. These incomes can be influenced and stimulated by the higher growth rates of the export sector, but these effects are difficult to observe and quantify. Additionally, regional and state consumer preferences provide influences that can stimulate the rate of growth of the endogenous and/or exogenous income industries.

B. EXPORT INDUSTRIES AND THE LOCATION QUOTIENT

To determine the composition of a state's economy and to define the nature of the export sector, a suitable method must be utilized to separate the export industries from the rest of the economy. By

adapting a formula developed by Walter Isard, industry personal incomes can be used to determine whether an industry derives a portion of it income from sources outside the state. The formula compares, by state, the ratio of a given industry percentage as a share of the total industry income to the state's total percentage share of the nation's total personal incomes. The result is the location quotient [Ref. 4:124]. The formula is stated below.

$$\frac{S_i/N_i}{S/N}$$

where:

S_i = wages in the industry in the state
S = wages in all industries in the state
N_i = wages in the industry in the nation
N = wages in all industries in the nation

If an industry has a location quotient of greater than one, the industry is considered to export at least a portion of its output outside of the state.

The formula is simple in nature, but it required further investigation. Expenditure patterns and consumer tastes and preferences can differ among the various regions. Additionally, income levels can vary among the states. These problems, coupled with an examination of the production practices between the states, must be examined to give meaning to the location quotient. [Ref. 4:125-126]

To accomplish this objective, each industry was examined to determine (1) if it can be considered an export industry for all states, and (2) its relationship to the size of all other industries' location quotient. A value of 1.3 for the location quotient was selected to alleviate

some of the problems created by consumer preferences and expenditure patterns. This value was compared to all location quotients of all industries which could be considered exogenous in each state.

For the purposes of this model, all farming, mining, transportation equipment, railroads, trucking, water transportation, and insurance carrier incomes were considered to be exogenous in nature for every state's economy, regardless of the actual size of the industry or its location quotient. This provided a base of export industries for each state's economy. Federal incomes and military wages and salaries were also considered to be derived from sources outside of the state. Property incomes were not examined because of the difficulty in determining which portion of the income should be considered exogenous and which portion endogenous to the state.

Table 1 provides a list by state of those industries considered to be in the export sector for each state. This information was derived using the definitions that were delineated earlier. The data was computed by examining the incomes by state and two-digit Standard Industry Codes for 1975 (Table 2). The model does not examine the shifts in the export sector which could have occurred during the 10-year period under examination.

C. EXOGENOUS INCOME GROWTH RATES AND DEFENSE SPENDING GROWTH

After completing an analysis of the state's economy, the incomes that were considered to be exogenously derived were summed for each year.

TABLE 1

INDUSTRIES BY STATE CONSIDERED EXPORT INDUSTRIES BY TWO-DIGIT SIC CODES

State	Mining	Manufacturing	Transportation	Finance	Services
Alabama	11,12	22,23,26,30,33,37,24,37	40,42,44	63,66	-
Alaska	13	24,37	40,42,44,41,45,46,48	63,67	70,73
Arizona	10	36,37	40,42,44,41	63,65,66	70
Arkansas	-	20,23,26,30	40,42,44,46	63,66	-
California	-	29,36,37	40,42,44,45,47	63,65	73,79,78
Colorado	10-13	31,38,37	40,42,44,45	63,65,67	70
Connecticut	-	30,34,35,37,38,39	40,42,44	63,66	-
Delaware	-	28,37	40,42,44,41,45,46,47,49	63	-
Florida	-	37	40,42,44,45,48	All	70,79
Georgia	14	20,22,28,26,24,37	40,42,44,45,46	63,66	-
Hawaii	-	20,37	All,48	All	70,79
Idaho	10,14	20,24,37	40,42,44	63,66	70
Illinois	-	20,27,29,34,35,36,37,39	40,42,44	62,63,66	-
Indiana	-	30,25,33,34,36,36,32,Motor Vehicles*	40,42,44	63	-
Iowa	14	20,30,35,37	40,42,44	63,66	-
Kansas	13	20,29,37	40,42,44,46	63,66	-
Kentucky	11,12,14	23,21,36,37	40,42,44	63	-
Louisiana	13,14	26,28,29,24,37	40,42,44,46	63,64,66	-
Maine	-	26,31,24,37	40,42,44,46	63,66	70
Maryland	-	33,37	40,42,44	63,65	73
Massachusetts	-	26,30,31,36,37,38,39	40,42,44,41	63,66	80
Michigan	-	25,33,34,35,37,Motor Vehicles*	40,42,44	63	-
Minnesota	10	20,26,27,35,37	40,42,44,45	63	-
Mississippi	13	23,26,30,24,25,37	40,42,44,46	63	-
Missouri	10,14	20,27,31,37,Motor Vehicles*	40,42,44,41,45	63	-
Montana	10,13,14	29,24,37	40,42,44,49	63,66	70
Nebraska	-	20,37	40,42,44,48	63,64,66	-
Nevada	10,14	37	40,42,44,41	63	-
New Hampshire	-	26,30,31,24,35,36,37,38	40,42,44	63,66	70,79
New Jersey	-	23,26,28,29,30,36,37,32,38,39	40,42,44,41	63,66	73
New Mexico	10,14	37,39	40,42,44	63	70,73

TABLE 1 (continued)

State	Mining	Manufacturing	Transportation	Finance	Services
New York	-	23,27,37,38,39	40,42,44,48,Total other	All	73,78,81
North Carolina	-	22,23,26,28,21,24,25,37	40,42,44	63	-
North Dakota	13	37	40,42,44,49	63,64	80
Ohio	11,12	30,33,34,35,37,32,Motor Vehicles*	40,42,44	63	-
Oklahoma	13	29,30,37	40,42,44,45,46	63,66,67	-
Oregon	-	26,24,37,38	40,42,44,49	63	-
Pennsylvania	11,12	23,29,33,34,37,32,39	40,42,44	63	-
Rhode Island	-	22,30,31,37,38,39	40,42,44	63,66	80
South Carolina	-	22,23,26,28,24,37,32	40,42,44	63	-
South Dakota	10,14	20,37	40,42,44,49	60,63,64,66	70,80,86
Tennessee	-	22,23,28,30,31,25,37	40,42,44	63	-
Texas	13	29,37	40,42,44,46,49	63	-
Utah	-	27,33,37	40,42,44	63	-
Vermont	14	26,27,24,25,35,36,37,32	40,42,44	63,66	70,80
Virginia	11,12	22,28,21,31,24,25,37	40,42,44,41,45	63,67	70
Washington	-	26,24,37	40,42,44,45,47	63	-
West Virginia	11,12	20,33,37,32	40,42,44,45,47	63	-
Wisconsin	-	20,26,31,34,35,37,Motor Vehicles*	40,42,44	63	-
Wyoming	10-13,14	29,37	40,42,44,46,49	63,66	70

*Motor vehicles are considered separate from SIC 37 in the BEA tables.

TABLE 2

STANDARD INDUSTRY CODE DESIGNATIONS

10 ----- Metal Mining
11 ----- Anthracite Mining
12 ----- Bituminous Coal and Lignite Mining
13 ----- Oil and Gas Extraction
14 ----- Mining and Quarrying of Nonmetallic Minerals
20 ----- Food and Kindred Products
21 ----- Tobacco Manufacturers
22 ----- Textile Mill Products
23 ----- Apparel and Other Finished Products Made from Fabrics and Other Similar Materials
24 ----- Lumber and Wood Products, except Furniture
25 ----- Furniture and Fixtures
26 ----- Paper and Allied Products
27 ----- Printing, Publishing, and Other Allied Industries
28 ----- Chemicals and Other Allied Products
29 ----- Petroleum Refining and Related Industries
30 ----- Rubber and Miscellaneous Plastic Products
31 ----- Leather and Leather Products
32 ----- Stone, Clay, Glass, and Concrete Products
33 ----- Primary Metal Industries
34 ----- Fabricated Metal Products Except Machinery and Transportation Equipment
35 ----- Machinery Except Electrical
36 ----- Electrical and Electronic Machinery Equipment and Supplies
37 ----- Transportation Equipment
38 ----- Measuring, Analyzing, and Controlling Instruments
39 ----- Miscellaneous Manufacturing Industries
40 ----- Railroad Transportation
41 ----- Local and Suburban Transit
42 ----- Motor Freight Transportation and Warehousing
44 ----- Water Freight Transportation
45 ----- Transportation by Air
46 ----- Pipelines Except Natural Gas
47 ----- Transportation Services
48 ----- Communication
49 ----- Electric, Gas, and Sanitation Services
60 ----- Banking
61 ----- Credit Agencies Other Than Banks
62 ----- Security and Commodity Brokers
63 ----- Insurance Carriers
64 ----- Insurance Agents
65 ----- Real Estate
66 ----- Combinations of Real Estate and Insurance Loan and Law Offices
67 ----- Holding and Other Investment Companies
70 ----- Hotels, Rooming Houses, and Camps and Other Lodging Places
73 ----- Business Services
78 ----- Motion Pictures
79 ----- Amusement and Recreation Services
80 ----- Health Services
81 ----- Legal Services
86 ----- Nonprofit Membership Organizations

ΣY_t

where Y_t = exogenous personal incomes in year t for each state.

The rate of change (or growth) (R) was determined for the exogenous personal incomes for each state for each year using the following formula. The exogenous income for 1975 was used as a base figure.

$$\Delta R = \frac{(\Sigma Y_t - Y_{75})}{Y_{75}}$$

where:

Y_t = exogenous personal income in year t for each state
Y_{75} = exogenous personal income in 1975 for each state

Defense spending was considered to be exogenous for all states and years. The model examines only two of the three sectors of defense spending, procurement dollars, and military wages and salaries. The Department of Defense civilian wages and salaries were not examined as part of the overall defense expenditures. This data is difficult to obtain in a "by state" format, and the figures cannot be reliably estimated.

In order to keep all observations in the same denomination, i.e., personal income dollars, procurement dollars must be converted to this measure. The methods utilized in the National Accounts for the determination of the Gross National Product provide the best method of accomplishing this end. Personal income is a function of National Income. National Income (NI) is the sum of all wages, interest, rents, and profits. In order to determine the portion of procurement dollars that is to be converted into personal income dollars, a ratio between NI and NI less corporate profit taxes, undistributed corporate profits,

and supplements to wages and salaries must be determined. This ratio must be multiplied by the ratio of the NI to GNP. The following formula using the 1975 figures for these accounts was utilized to determine the percentage of procurement dollars that should be converted into personal income.

$$\frac{NI}{GNP} \times \frac{(NI - (1, 2, \text{ and } 3))}{NI}$$

where:

NI (National Income)	=	1262.6B
GNP (Gross National Product)	=	1572.9B
1 = Corporate Profit Taxes	=	36.5B
2 = Undistributed Corporate Profits	=	42.8B
3 = Supplements to Wages and Salaries	=	83.4B

The result of the formula using the figures form the Survey of Current Business figures from 1975 reveals that approximately 70 percent of purchase or procurement dollars are converted into personal income dollars. Since defense procurement usually occurs over a period of time greater than a year, this figure should be adjusted to reflect this fact. For the purposes of this study, 70 percent of each year's estimated procurement dollars was allocated to that year. Data for each year's exact expenditure of defense procurement dollars by state and year is unavailable. There exists no reliable method for effectively computing these figures. The summation of all previous years' expenditures and precise amount spent in the year being examined should closely approximately the 70 percent conversion figure.

Defense spending growth rate (R_d) was determined by summing the total of military wages and salaries and procurement dollars con-

verted to a personal income basis. The following formula was used to determine the rate of growth or change (R_d). The defense spending total for 1975 was used as a base figure for each state.

$$\frac{(\Sigma Y_d - Y_{75})}{Y_{75}} = \Delta R_d$$

D. THE RELATIVE CONTRIBUTION OF DEFENSE SPENDING TO EXOGENOUS INCOME

The relative contribution of defense spending to exogenous income was derived using the growth (or changes) in exogenous incomes and the defense expenditure for each state. The percentage of defense income to the total of the state exogenous income was multiplied by the growth rate or change in defense income. This figure indicates the proportion of growth of defense spending during the periods being examined. By dividing the percent change in the ratio of defense-derived incomes to the exogenous income totals by the rate of change or growth in the exogenous income, a percentage contribution of defense spending to exogenous income can be determined. The following is the formula that was used in this study.

$$\frac{D_{75}/Y_{75}}{\Delta R} \times \Delta R_d$$

where:

D_{75}/Y_{75} = ratio of defense spending to total exogenous personal income in the base year 1975

ΔR = growth rate or the change in level of exogenous income from 1975 until 1985

ΔR_d = growth rate or the change in the level of defense spending from 1975 until 1985

The results of the ratio of defense spending to the total exogenous personal income are presented in Table 3. Table 4 presents the results of the calculation for the relative contribution of defense spending to exogenous incomes.

The inflation rate for both periods significantly influences the relative contribution figures in Table 4. To correct the results to a base year of 1975 dollars, the relative contribution rates were divided by a correction factor of 1.55 for the first period and 1.97 for the second period. These correction figures were derived from the Department of Defense standard deflators table [Ref. 5:46]. The inflation-adjusted data are listed in columns 2 and 4 for the respective periods.

E. ANALYSIS OF THE RESULTS AND PROBLEMS IN THE EXPORT-BASED MODEL

The degree of stimulation of each state's economy was determined to be the growth provided to exogenous income by defense expenditures in that state. The figures provided in Table 4 examine the relationship between the relative contribution of defense spending to exogenous incomes and the degree of stimulation defense spending provided to each state's economy. The level of stimulation was divided into four distinct categories of heavy, moderate, little, or depressed. These divisions were adapted from Bolton's original analysis.

An examination of the data in both Tables 4 and 5 indicates some of the major flaws in the export-based modeling technique. For

TABLE 3

PERCENTAGE OF DEFENSE SPENDING TO EXOGENOUS INCOME (1975 AND 1985)

State	1975	1985
Alabama	13.15	18.37
Alaska	26.20	29.65
Arizona	29.40	29.71
Arkansas	6.62	16.34
California	24.96	29.23
Colorado	18.14	23.92
Connecticut	34.26	38.19
Delaware	9.65	14.12
Florida	13.46	23.34
Georgia	15.26	24.91
Hawaii	28.45	32.69
Idaho	6.20	7.06
Illinois	4.44	7.15
Indiana	7.40	15.09
Iowa	3.24	6.98
Kansas	21.01	33.03
Kentucky	13.71	15.47
Louisiana	14.13	21.21
Maine	12.73	33.27
Maryland	18.83	34.06
Massachusetts	18.85	30.11
Michigan	4.51	6.97
Minnesota	13.49	15.96
Mississippi	38.80	30.80
Missouri	20.50	48.14
Montana	6.08	11.40
Nebraska	7.67	9.23
Nevada	8.98	7.37
New Hampshire	19.22	18.74
New Jersey	8.82	11.87
New Mexico	15.26	19.10
New York	9.09	9.63
North Carolina	14.92	16.92
North Dakota	16.72	16.20
Ohio	5.31	11.54
Oklahoma	13.70	15.16
Oregon	3.37	4.81
Pennsylvania	6.50	14.89
Rhode Island	9.82	16.63
South Carolina	20.54	20.94

TABLE 3 (continued)

State	1975	1985
South Dakota	5.90	8.02
Tennessee	10.15	9.94
Texas	15.69	40.94
Utah	11.68	24.19
Vermont	12.82	7.64
Virginia	32.49	28.50
Washington	30.72	21.18
West Virginia	2.36	2.23
Wisconsin	3.15	7.71
Wyoming	7.24	9.39

example, New York, which receives an average of eight percent (1975-1985) of the defense procurement dollar, is placed in category 1, where the economy shows that the contribution of defense spending to exogenous income provided little or no growth. This incorrect classification of defense spending effects in New York is caused by the nature of the state's economic structure. New York is a major industrial and financial center in the United States. It receives a disproportionate share of incomes from all industries when compared to the rest of the nation. In this case, along with Michigan and Illinois, the export-based model provides less than adequate analysis of the true effects of defense spending on each state's economy.

The opposite problem is observed in states such as Maine and Kansas that have economies less dependent on a heavy industrial base. The stimulation to their respective economies should be less than is

TABLE 4

RELATIVE CONTRIBUTION OF DEFENSE SPENDING TO EXOGENOUS INCOME

State	Relative Contribution 75-80	Inf. Corr.	Relative Contribution 75-85	Inf. Corr.
Alabama	9.98	6.42	23.46	11.92
Alaska	58.91	37.91	32.80	16.66
Arizona	5.22	3.36	29.91	15.19
Arkansas	9.07	5.84	26.12	13.27
California	17.47	11.24	31.80	16.15
Colorado	7.71	4.96	28.37	14.41
Connecticut	30.82	19.84	41.73	21.20
Delaware	37.03	23.83	18.69	9.49
Florida	13.05	8.40	33.85	17.19
Georgia	31.78	20.45	14.73	7.48
Hawaii	10.93	7.03	38.52	19.57
Idaho	4.25	2.74	8.07	4.10
Illinois	11.57	7.45	6.73	3.27
Indiana	8.30	5.34	25.01	12.70
Iowa	8.85	5.70	14.99	7.61
Kansas	20.68	13.31	43.40	22.04
Kentucky	7.32	4.71	17.07	8.67
Louisiana	1.80	1.16	21.00	10.67
Maine	37.50	24.13	48.85	24.81
Maryland	25.22	16.23	37.66	19.13
Massachusetts	27.22	17.52	33.89	17.21
Michigan	6.71	4.32	9.27	4.71
Minnesota	25.28	16.27	29.86	15.17
Mississippi	-13.76	-8.86	20.36	10.34
Missouri	47.21	30.38	74.86	38.02
Montana	6.27	4.04	26.69	13.56
Nebraska	23.56	15.16	8.87	4.51
Nevada	3.59	2.13	6.03	3.06
New Hampshire	9.14	5.88	15.69	7.97
New Jersey	5.74	3.69	13.99	7.11
New Mexico	14.64	9.42	17.59	8.93
New York	7.56	4.87	9.23	4.69
North Carolina	17.32	11.15	17.56	8.92
North Dakota	32.05	20.63	12.99	6.60
Ohio	4.66	3.00	19.27	9.79
Oklahoma	10.26	6.60	16.31	8.28
Oregon	3.26	2.10	6.27	3.18
Pennsylvania	10.35	6.66	27.72	14.08
Rhode Island	21.83	14.05	19.78	10.05

TABLE 4 (continued)

State	Relative Contribution 75-80	Relative Contribution 75-80 Inf. Corr.	Relative Contribution 75-85	Relative Contribution 75-85 Inf. Corr.
South Carolina	9.95	6.40	19.96	10.14
South Dakota	8.43	5.43	9.92	5.04
Tennessee	4.56	2.93	9.73	4.94
Texas	33.12	21.32	102.49	52.06
Utah	11.67	7.51	34.60	17.57
Vermont	.80	.51	3.74	1.90
Virginia	47.58	30.62	27.02	13.72
Washington	12.23	7.87	16.84	8.55
West Virginia	.94	.60	2.03	1.03
Wisconsin	2.26	1.45	11.44	5.81
Wyoming	1.74	1.12	11.18	5.68

TABLE 5

DEFENSE SPENDING STIMULATION OF STATE ECONOMIES

Depressed or No stimulation (Percentage of Relative Contribution)	Little Stimulation	Moderate Stimulation	Heavy Stimulation
<0-5	**6-10**	**11-15**	**16+**
Idaho	Delaware	Alabama	Alaska
Illinois	Georgia	Arkansas	Arizona
Michigan	Iowa	Colorado	California
Nebraska	Kentucky	Indiana	Connecticut
Nevada	New Hampshire	Louisiana	Florida
New York	New Jersey	Mississippi	Hawaii
Oregon	New Mexico	Montana	Kansas
Tennessee	North Carolina	Pennsylvania	Maine
Vermont	North Dakota	Rhode Island	Maryland
West Virginia	Ohio	South Carolina	Massachussetts
Wisconsin	Oklahoma	Virginia	Minnesota
Wyoming	South Dakota		Missouri
	Washington		Texas
			Utah

indicated in the figures on Tables 4 and 5. These states received a very small share of the defense procurement dollar (Maine 0.2% 1975, 0.7% 1985; and Kansas 1.4% 1975, 1.5% 1985). The small size of the state's total export industry tended to bias the results and give a larger relative growth rate during the period under examination.

In a critique of the export-based model by Richardson (1973), other drawbacks of the use of export-based studies were examined [Ref. 6:17-21]. Richardson's criticisms were:

1. Autonomous investment and technical progress are neglected;
2. Population effects are not sufficiently addressed;
3. A rapidly expanding region can have a falling export growth rate;
4. The technique fails to examine the effects of differing levels of incomes and tax structure between the states;
5. The technique utilizes a broad definition of what comprises exogenous and endogenous incomes;
6. The technique arbitrarily assigns a sector of exogenous income industries; and
7. It fails to examine varying price levels between the states.

An alternative to the export-based model is to estimate the effects of defense spending on the states' economies. Chapter III will discuss the methodologies of regional econometric modeling. Chapter IV will present the results of an econometric analysis of the various components of state growth.

III. REGIONAL ECONOMETRIC MODELS

A. INTRODUCTION

The following quote provides a functional definition of regional econometric modeling.

> A regional econometric model is a set of equations, perhaps highly simultaneous, describing the economic structure of a regional economy, usually a state or providence or metropolitan area. The parameters are estimated econometrically ... [and] the equations are arranged in a certain logical group which reflects economic theory as applied to product markets, labor markets, firm behavior, government behavior, migration, etc. [Ref. 2:495]

There are three distinct levels of regional models. These levels are: (1) the single-region model; (2) the multiregion model; and (3) the national-multiregional model. Each model is different in structure and can take on the aspects of a "top-down" or "bottom-up" approach to examine the economic flows.

B. SINGLE-REGION MODELS

In a single-region model, the first step is to relate certain values of the regional variables (X_r), such as prices and population, to those national variables (X_n) that correspond accordingly. It is assumed that the national variables will be exogenous at the regional level, but will be endogenous at the national level. This method is referred to as the "top-down" approach to regional modeling [Ref. 6:018]. A simple "top-down" model is illustrated in the diagram below.

National Model $\longrightarrow$ X_n $\longrightarrow$ X_r $\longrightarrow$ Regional Model

This model is considered to be a satellite of the national model. At this stage of the modeling process, an assumption is made that the regional model is dependent on the national economy. It is based on the analogy between the economics of a region and that of a small country. It can be assumed that the size is small enough that the region does not have any major impact on the national economy. The region, however, exhibits a strong dependence on the dominance of the national economy.

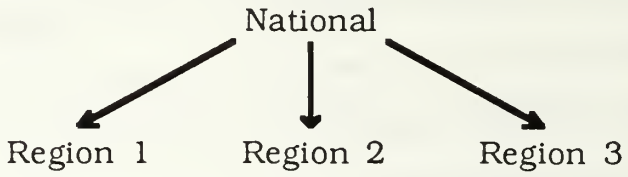
A difficulty of the purely "top-down" approach is the errors that can be generated at the regional level. Regional and national business do not always run concurrently. The topics of migration, competition, and trade between regions is not sufficiently addressed in the "top-down" modeling method.

The linkages between the nation and the region are not only modeled at the level of regional exports, but also as a relationship between interregional and national prices. Additional linkages between the national model and the regional model are introduced into the scenario. The wage rate, the cost of production, and regional import prices must be entered into the modeling equations. The interest rate is considered to originate from the national model. [Ref. 7:109]

C. MULTIREGIONAL MODELS

The multiregional model divides the nation into a number of smaller regions. Klein (1969) proposed a regionalization concept in a purely "top-down" approach. The aim of the "top-down" model is to

disaggregate the national values to the levels of the different regions. These different regions would constitute the overall national economy. the "top-down" approach takes the national totals, such as population and wages, and allocates these totals to the various regions.

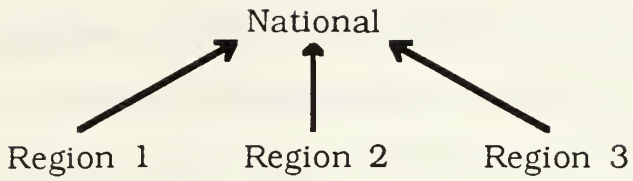


The pure "top-down" model

One difficulty with this modeling technique is the lack of feedback loops between the various regions and the nation. This model is useful if one wants to examine the impact of economic decisions at the national level on the regions being examined. It assumes that decisions at the regional level have no effect on the nation. These models assume that the regional analysis is totally dependent upon national variables.

Another difficulty of the purely "top-down" approach is the errors that can be generated at the regional level. Again, regional and national business cycles do not always run concurrently. The topics of interregional migration, competition, and trade between the regions are not sufficiently addressed in this modeling method.

An alternative multiregional modeling method is called the "bottom-up" approach. This model aggregates the regional activities to the national level.



The pure "bottom-up" model

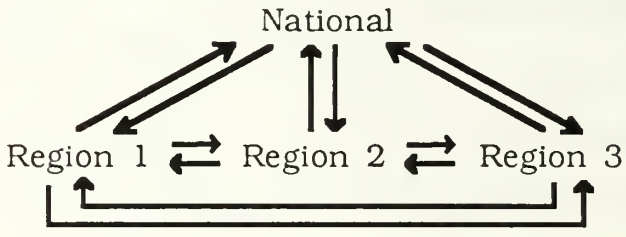
The National-Regional Impact Evaluation System (NRIES) is an example of a primarily "bottom-up" model. The model is comprised of fifty state models and a model of the District of Columbia. It was created by the Bureau of Economic Analysis of the U.S. Department of Commerce. The model includes the following variables: employment, wages, industrial output, non-wage income sources, state and local government revenues and expenditures, personal and non-personal tax payments, and demographic variables. [Ref. 7:149]

The regional components of the model are comprised of the individual state models and the D.C. model. Two sets of variables are examined—the internally determined and externally determined variables. The internally determined variables model the internal linkages within each state model. The external variables model the external linkages between the states and the nation.

There are several major problems with the "bottom-up" approach. the simplified model fails to account for the differing relationships among the regions. It assumes that every region competes equally with all other regions. The model also fails to recognize that there exist feedback relationships between the national economy and the regional economies.

D. NATIONAL-MULTIREGIONAL MODELS

The national-multiregional models combine the top-down and bottom-up approaches to give a balanced view of the economic flows in the nation. The model consists of three basic linkages: the nation to the regional level, the regions to regions, and the regional level to the nation. The flows recognize that there are relationships that must be determined on the national level, such as interest rates. Activities such as the labor market are determined on the local level. The national-multiregional approach views some of the national variables to be exogenous and others to be endogenous. The national and regional variables cannot be independently determined.



A simple national-multiregional model

National-multiregional models provide the most complete analysis of all economic relationships in the economy. However, the complexity of the interrelationships and the ability to successfully mathematically model all the various relationships make it difficult for the modeler to accurately reflect all of the economic phenomena that are to be examined. A decision must be made on what sort of combination of national and regional effects will be modeled. This specialization of the model to examine one specific area of special interest will cause other areas to be treated simplistically. This will provide a model that

is less than satisfactory in tracking the overall national-multiregional economy. This model will track the modeler's area of interest with a high degree of accuracy if the data and maintained hypothesis are proven.

E. APPROACHES IN THIS STUDY

There is a proliferation of models available for economic analysis. Each technique has its advantages and disadvantages in representing specific sectors of the economy, both regionally and nationally. The choices between the modeling technique to be used is driven by the modeler's specific interest.

Although the export-based model presented in Chapter II is not a true econometric model, it possesses the attributes of a simple national-multiregional approach. The exports represent the linkages between the regions and the nation. Defense expenditures flow from the national level to the regional or state level. However, the model fails to account for the differences between the states, such as wage rates and tax structures.

The next chapter will present a multiple regression analysis of the elements which comprise these various aspects of these state differences. It will examine the relationships between the levels of state and federal expenditures (including defense spending) and some elements which comprise the business climate of each state.

The multiple regression model takes the perspective of a "top-down" approach. It will examine the effects of the components of

federal and state expenditures on total personal incomes during the period 1973 through 1983.

IV. A SIMPLE ECONOMETRIC MODEL

A. AN OVERVIEW OF REGIONAL GROWTH MODELS

Many factors are important in determining regional growth rates. Among the most important are net migration, population, public expenditures, tax rates, wage rates, and the business climate.

Studies conducted by Pidot [Ref. 9] and Wilensky [Ref. 10] have found a positive correlation between levels of public expenditure in urban areas and population density (population per square mile). It can be argued that the higher expenditures by urban governments may be attributed to the greater range of services offered there [Ref. 8:78]. It is expected that states showing a larger degree of economic growth would duplicate these overall trends.

Romans and Subrahmanyam [Ref. 11] proposed a simple model of state growth which assumes that all factors from the private and public sectors that affect state growth will affect all states in the region equally [Ref. 11:442]. States in their model were assumed to be identical with the exception of the tax rate and public expenditure variables. In this analysis, the level of personal income was positively correlated with the tax rate [Ref. 11:443]. Their single equation model was determined and the partial regression coefficients were considered to be the average for the states in the sample.

Muth [Ref. 12], in a detailed examination of migration and employment growth, found that each affect and are affected by each

other. The analysis also concluded that employment tends to grow in proportion to migration and is inversely related to unemployment.

All of these models were considered when constructing the elements and variables to be used in this study. As in the Romans and Subrahmanyam model, a single equation model was thought to best represent the average effects of defense spending on growth for all states.

The following sections will discuss the approach taken and variables used, and present the findings.

B. A MULTIPLE REGRESSION APPROACH

In this portion of the study, pooled cross-sectional data for the 48 contiguous states was utilized; the model attempts to estimate the independent effect of defense procurement expenditures on total personal income during the period 1975 through 1983. It examines data describing the various components of federal and state expenditures, along with several of the components which comprise the "business climate" of the states.

During the period under examination (1975-1983), total personal income increased by 15.5 percent for the United States in 1975 dollars, and defense procurement dollars increased by 44.2 percent. The phenomenon which will be examined in this portion of the study is the impact of this dramatic increase in defense spending on the economic subsystems of the United States and of the individual states.

The best technique for examining these effects is multiple regression analysis. The theoretical construct underlying the multiple

regression model is to relate the changes in the dependent variable (total personal income) over the period of time and across the states to changes in the independent variables. The independent variables should capture the effects of state and federal expenditures. As in the export-based model, these expenditures by the government eventually will be converted into personal income dollars.

For the purposes of this study, it is assumed that these personal income dollars will remain in the state where originally spent. In other words, the state will not hire private contractors from outside the state to build its highways and schools. The same assumption is also applied to the defense procurement dollars.

C. DATA COLLECTION AND SOURCES

Data for the dependent and independent variables were obtained from the following sources. These are the data from which the variables for the multiple regression equation were constructed.

1. Total Personal Income: Total personal income by year and state from all sources. Source: Personal Income by Source and Earnings by Industry (1963-1985) (U.S. Department of Commerce, Bureau of Economic Analysis).
2. Population: The overall population of the states by year. Source: Statistical Abstract of the United States 1985, Table 8 (U.S. Department of Commerce).
3. State Area: The total land area of the individual states. Source: Statistical Abstract of the United States 1985, Table 334 (U.S. Department of Commerce).
4. Military Procurement: The prime military contract awards for 1975 through 1983 greater than $10,000. Source: Department of Defense Prime Contract Awards by Region and State Fiscal Years 1963-1983 (Directorate for Information Operations and Reports, The Pentagon).

5. Federal Education and Highway Expenditures: Intergovernmental revenues received by the state by year for education and highways. Source: State Government Finance (GF8), issues 1975-1983, Table 7; State Government Revenue by Source (U.S. Department of Commerce).
6. State Education and Highway Expenditures: Expenditure by state and year for highways and education. These outlays do not include federal dollars in the same areas. Source: Governmental Finances (GF8), 1975-1983, Table 20; Capital Outlays of State and Local Governments in Total and for Selected Functions (U.S. Department of Commerce).
7. Manufacturing Employment: The number of employees on manufacturing payrolls. Source: Handbook of Labor Statistics, June 1985, Table 83; Employees on Manufacturing Payrolls by State, 1945-1983 (U.S. Department of Labor, Bureau of Labor Statistics).
8. Tax Data: The source of general revenue for the states by year. Source: Government Finances (GF8), 1975-1983, Table 22; Per Capita Amounts of Selected Items of State and Local Government Finances (U.S. Department of Commerce).
9. Right to Work Laws: The states which had effective right-to-work laws in 1978. [Ref. 13:497]

D. VARIABLES USED IN THE ANALYSIS

The results are based on an analysis of the annual data for the period 1975 through 1983 for the 48 states. The dependent variable for the analysis is total state personal income. There were a total of 336 complete observations after deletions for missing data. Tax data was unavailable for 1978 and 1980. The elements of state expenditures were unavailable for 1978.

There were five basic categories of independent variables: (1) federal education and highway spending by state and year; (2) state and local capital expenditures for education and highways by state and year; (3) defense procurement dollars by state and year; (4) three components which are proxies to represent the business climate of

the state; and (5) population density. All monetary variables were adjusted to 1975 dollars to compensate for the effects of inflation.

Three proxies were used for the state's business climate: the manufacturing wage, the overall tax rate, and the right-to-work laws. These proxies were selected because of the increased emphasis that many state and local officials and businessmen have placed on these as factors in attracting industry and promoting state and local growth. The exact definition of what constitutes a good business climate is unclear, but it is usually associated with these variables. [Ref. 14:99]

The manufacturing wage rate was calculated by dividing the state wages in manufacturing (from the BEA tables) by the total number of personnel on the state manufacturing payrolls (from the BLS tables). This method is relatively crude, but the results are adequate to serve as a basis for an analysis of the average manufacturing wage rates by state and year.

The tax rate proxies were determined with similar methodology. By using the per capita tax data for total tax receipts (including property taxes) and the per capita income data, a tax rate proxy was calculated. It is difficult to determine anything but a crude estimate of the individual tax burden in each state. The use of statutory tax rate schedules is unsatisfactory because of the lack of uniformity in state tax definitions and the variations in the ways that the state and local governments share the responsibilities for taxation. [Ref. 16:577]

The other variables were determined directly from the sources and converted to the same denomination (millions of dollars).

Population density was determined by using population and area data for each state and year being examined. The mean, maximum, minimum, and standard deviations for all the variables are presented in Table 6.

TABLE 6

DESCRIPTIVE STATISTICS

Variable	Mean	Std. Dev.	Min.	Max.
Total Personal Income*	29951.7	33672.9	2465.17	193415
Population Density†	149.3	208.6	3.91	959
Military Procurement*	952.3	1656.4	5.10	15028
Fed. Education Spending*	163.2	157.6	10.32	953
Fed. Highway Spending*	108.6	79.5	12.12	488
State Education Spending*	210.5	205.7	6.80	1398
State Highway Spending*	314.1	274.2	24.04	1778
Mfg. Wage Rate	12850.01	1988.75	9095.00	19303
Tax Rates	10.3	1.5	6.84	21

*Millions of dollars
†Density = population per square mile

E. CORRELATION ANALYSIS

The simple correlation coefficient (r) measures the degree to which variations (or changes) in one variable are related to the variations in another variable. The coefficient provides an easy method to compare the strength of the relationship between pairs of variables. The values of the coefficients range from a perfectly negative correlation (-1.0) through no relationship (0.0) to a perfectly positive correlation (+1.0). Table 7 presents the correlation matrix of all the

variables used in the analysis; the figures are Pearson's (simple) correlation coefficients.

An examination of the simple correlation between state highway (SH) and education (SE) expenditures and federal highway (H) and education (E) expenditures reveals a high degree of positive correlation (0.86 and 0.83, respectively). This correlation is due largely to the fact that states that spend heavily in these areas also get substantial federal funding. (Federal expenditure variables in these two areas do not include any matching funds.)

The high degree of correlation (0.802) between military procurement spending (M) and federal education expenditures (E) is not so easily explained. However, an examination of the raw data reveals that high-growth states have a larger share of the defense procurement dollar and population. This is a cause-and-effect relationship. The faster-growing states need more inputs from the federal level to build and maintain the schools for the expected and realized increases in population.

Other relationships which showed high degrees of correlation were considered spurious in nature. These relationships were caused by the naturally increasing levels of public expenditure as a state grows. Since these variables move together, high correlations are observed.

These six combinations of variables, all components of federal and state expenditures, show a high degree of correlation ($r > 0.07$). This

TABLE 7

PEARSON CORRELATION COEFFICIENTS

/ PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	T	D	M	E	H	SE	SH	WG
T	1.00000	0.25668	0.83243	0.95649	0.83025	0.86289	0.80080	0.33990
	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	432	432	432	432	432	384	384	432
D	0.25668	1.00000	0.21884	0.14256	0.05416	0.09005	0.07079	0.16713
	0.0001	0.0000	0.0001	0.0030	0.2613	0.0780	0.1663	0.0005
	432	432	432	432	432	384	384	432
M	0.83243	0.21884	1.00000	0.80184	0.63387	0.65868	0.57286	0.22484
	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001
	432	432	432	432	432	384	384	432
E	0.95649	0.14256	0.80184	1.00000	0.85536	0.86977	0.82078	0.25408
	0.0001	0.0030	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001
	432	32	432	432	432	384	384	432
H	0.83025	0.05416	0.63387	0.85536	1.00000	0.81090	0.83655	0.26276
	0.0001	0.2613	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001
	432	32	432	432	432	384	384	432
SE	0.86289	0.09005	0.65868	0.86977	0.81090	1.00000	0.86537	0.30890
	0.0001	0.0780	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001
	384	384	384	384	384	384	384	384
SH	0.80080	0.07079	0.57286	0.82078	0.83655	0.86537	1.00000	0.27128
	0.0001	0.1663	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001
	384	384	384	384	384	384	384	384
WG	0.33990	0.16713	0.22484	0.25408	0.26276	0.30890	0.27128	1.00000
	0.0001	0.0005	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
	432	32	432	432	432	384	384	432
TX	0.09189	0.09425	0.04314	0.07995	-0.02048	0.02460	-0.02203	0.22165
	0.0926	0.0845	0.4306	0.1436	0.7084	0.6532	0.6875	0.0001
	336	336	336	336	336	336	336	336

where:

T = State Total Personal Income
D = Population Density
M = Military Procurement Dollars
E = Federal Education Expenditures
H = Federal Highway Expenditures
SE = State Education Expenditures
SH = State Highway Expenditures
WG = Average Manufacturing Wage Rate
TX = Tax Rate Proxy

high degree of correlation makes it difficult to isolate the effect that these highly colinear variables have on state personal income. However, ordinary least squares estimates are still unbiased if the model meats the *a priori* theoretical expectations about the sign and size of the parameters of the function.

This lack of independence between these highly correlated variables causes a multicolinearity problem. With the time-series data, the variables tend to move together. There are several approaches that can be taken to correct this problem. These are:

1. Augment the sample by adding additional information;
2. Scale down the model and drop some of the explanatory variables; or
3. Recognize the problems and take the approach that multicolinearity is a basic property of the population sampled. [Ref. 15:155]

In this analysis, the third approach was taken. The major drawback is that the standard errors of the parameter estimates tend to be large, reducing the likelihood of finding statistically significant effects.

F. MODEL SPECIFICATIONS

The model is based on a similar model examining state growth and local taxes by Helms (1985). In the Helms model, the dependent variable was total personal income by state and year, and the independent variables were the various components of taxes, federal source revenues, components of state and local expenditures and elements representing growth (population density), and the business climate of the state [Ref. 16:579].

Included in the Helms model are binary or dummy variables to represent both the state and time effects of the pooled cross-section and time-series data. The binary variables recognize the existence of real state and year differences. The inclusion of the state dummies captures the effects of unmodeled differences among the states, such as climate and pollution.

In this study, the binary variable representing the state of Alabama was deleted as the reference state. The state dummies therefore show differences in personal income among states, compared with the omitted state Alabama.

The year dummies were used to remove the effects of the upward shifts in the states' economies. It is postulated that there will be a definite upward trend between each year.

In the final two models, a right-to-work dummy was included to represent the states which had right-to-work laws as of 1978. This variable was inserted because the existence of right-to-work laws affects a state's economic growth. States with right-to-work laws tend to be less unionized and employers tend to have increased leverage in determining the level of wages that are to be paid [Ref. 16:495]. States with right-to-work laws tend to be those with lower personal income. This could be considered another element of a business climate for the individual states.

G. MULTIPLE REGRESSION RESULTS

The model was estimated using ordinary least squares (OLS) regression on SAS. The results of the regression on the basic model,

the model with the year and right-to-work dummies, and the model with all factors included are presented in Table 8. The computer output for each model appears in Appendix A.

The first equation examined was a regression of all of the variables contained in the model, except the state, time, and right-to-work law dummies. The results are less than satisfactory. The *a priori* expectations of negative signs for the coefficients for the average manufacturing wage rate and tax rate proxy were not observed. An examination of the Durbin-Watson value (0.887) indicated that the model had a degree of positive autocorrelation between the residuals. However, most of the explanatory variables were significant, the only exception being the tax rate proxy.

The second equation estimates a regression model that includes the time effect dummies and right-to-work law dummy. The *a priori* expectation of the negative influence of the tax rate proxy is observed and is significant at the 0.06 level. The Durbin-Watson value of 0.862 also indicated that autocorrelation among the error terms is still present.

Clearly, both models without the inclusion of both the state and time dummies failed to adequately model the relationship between defense spending and state personal income. Helm [Ref. 16] conducted similar tests to support the inclusion of the state and time effect dummy variables in his model of state growth and taxes.

TABLE 8

REGRESSION ESTIMATES

	OLS	Time Effects Right-to-Work Dummy	State and Time Effects With Right-To-Work Dummy
Population Density	16.68 (8.012)	14.14 (6.634)	320.114 (8.044)
Military Procurement	3.805 (9.056)	3.438 (7.908)	3.578 (15.049)
Fed. Education Spending	124.11 (14.918)	127.57 (15.149)	-16.009 (-3.804)
State Education Spending	21.0315 (4.237)	21.3937 (4.208)	7.302 (4.284)
State Highway Spending	3.8483 (1.084)	7.57852 (1.888)	3.527 (3.027)
Mfg. Wage Rate	1.0582 (4.564)	0.03528 (0.176)	-0.5344 (-0.136)
Tax Rate	281.523 (0.985)	-432.314 (-1.883)	-92.707 (-0.704)
Right to Work	N/A	-5322.71 (-6.050)	-4382.73 (-0.182)
Intercept	-241494.88	*	*
F-Statistic	776.015	776.893	3770.741
R^2	.9487	.9719	.9986
Durbin-Watson Statistic	0.887	0.862	1.365

*No intercept was used in the equations that include dummy variables
(T-ratios in parentheses)

The final model, which included all state, time, and right-to-work dummies, provided the best overall results. The F-statistic for the equation was 3770.741. Thus, the hypothesis that all of the regression coefficients are zero is rejected with high confidence (p=0.0001). Therefore, there does exist a relationship between personal income,

the various expenditure variables, and the business climate indicators. The R^2 value of 0.9986 is an artifact of the inclusion of the state and time effect dummies and serves no useful purpose in indicating the predictive power of the model.

The OLS estimates presented in column 3 of Table 8 provide the basis for an analysis of the empirical results of the regression. The model indicates that increasing military spending has a significant and positive effect on state personal income. The manufacturing wage rate yielded a negative coefficient, which was expected because of the effect higher wages have on producer cost functions. Industries would not tend to locate in areas where the wage rate was higher than average and growing. The results of industry location and higher wage rates would have a negative effect on total state personal income. Even though the wage rate coefficient was not significant (t-ratio = 0.136), the negative value agreed with previous findings. [Ref. 16:579; 11:439]

The federal education and highway expenditure variables are negative and significant. Helms (1985) encountered the same negative coefficients in his analysis. His reasoning for the negative relationship with personal income was the reflection of state matching fund requirements and the special nature of these revenues [Ref. 16:579]. The reason for this negative relationship is the requirement for states to raise matching funds in order to utilize the federal funds. The states would raise these funds by either a tax or user fee, and this would have a negative impact on the total state personal income.

The negative and insignificant effect of the right-to-work law coefficient was unexpected. This effect could be caused by the fact that only the poorer states have right-to-work laws. This fact was confirmed using the raw data and the list of applicable states. The inclusion of the right-to-work law dummy served only to net out an effect that would have been reflected in the state dummies, had they not been included.

The positive and significant values of the state spending and military spending coefficients indicate the degree of stimulation that these expenditures have on the states' economies. The point elasticity for military spending is 0.114, which indicates that personal income is relatively inelastic with respect to military spending. This indicates that an increase in defense spending will increase total personal income, but that the percentage effect is relatively small. However, the elasticity of defense spending is twice the magnitude of the elasticity of state educational spending (0.05).

It must be remembered that this model does not indicate that a one-dollar increase in military spending will increase personal income by 3.58. The model simply provides the reader some insight into the degree that defense spending influences state personnel income growth in comparison to the other components of federal and state expenditures.

The printout of the final model in the Appendix gives the values of the state and time dummies. These simply show the total personal income differences between the years and the states. Since the

coefficients for the modeled variables represent the average for all stated examined, the dummy variable coefficient values must be added into the final equation if one wishes to examine a particular state or year.

H. SUMMARY OF ANALYSIS

The data for the period 1975 through 1983 confirms that defense purchase dollars have both a positive and significant effect on the level of total personal income. The examination of the federal expenditure coefficients for education and highway spending have both a negative and significant impact on personal income. This indicates that defense spending has the largest positive impact on state personal income of all federal expenditures (excluding transfer payments to individuals). However, this is in part because there is no negative offset, as in the case of highway and education funds. The wage rate, which in most of the previous studies has been identified as the primary factor in explaining growth in personal income, was found to be relatively unimportant in this model.

After controlling for both the state and year effects, the tax rate and the existence of right-to-work laws were found not to be significantly related to personal income growth. State personal income growth seems to be most highly affected by defense procurement spending and state education and highway spending. High levels of spending by states does not seem to deter the growth of personal income, as first might be expected, perhaps because rapidly growing states spend more on public services.

In conclusion, support is provided to the hypothesis that defense spending is an important aspect of regional growth when that growth is measured in personal income dollars.

V. SUMMARY AND CONCLUSIONS

In conclusion, this study has shown that the economic development of the states has been significantly affected by the increases in defense expenditures since 1975. Military spending programs account for the bulk of the goods and services purchased by the entire federal government. These increased expenditures have served as a means of expanding the federal government's role as a purchaser and consumer in the economies of the states.

Because of the specialized nature of the goods and services required by the military, only a few relatively large industries provide most of these needs. However, these companies are still motivated by economic factors such as a cheap supply of labor and the availability of transportation within a state. It is these factors which must also be entered into the calculus of analyzing defense spending and regional growth.

In both the export-based and econometric models, elements of industrial location were addressed. The importance of these elements cannot be overemphasized. The cost of labor is just one factor that must be examined in determining why an industry locates in a certain state. One must also examine the costs of transportation in any labor market region. It is an analysis of the costs and benefits of both of these criteria which determines where industry will locate.

Defense spending naturally gravitates towards those areas which are industry intensive. For example, New York and California, which average 7 percent and 20 percent of the defense procurement dollar annually, are both highly industrialized states, not just in defense-related industries. These states have well-developed transportation systems and extensive port facilities. The defense industry which requires extremely specialized materials, such as an aircraft manufacturer, would locate in states such as these.

Conversely, states such as Idaho, North Carolina, and Iowa (0.05, 0.7, and 0.3 percent of the defense procurement dollar, respectively, in 1985), which have agrarian economies, experience little growth caused directly by defense spending. Of course, there are military installations in these states, but the overall benefits of these bases appear to be more local in nature. They do not appear to have spillover benefits to the state as a whole.

The effects of the interregional multiplier stress the impact of defense spending on all other sectors in the regional and national economy. The continuous back-and-forth play of forces caused by defense spending is difficult to quantify. Since defense spending comprises the majority of the goods and services bought by the government, the implication of a cutback in spending is the negative effect that such a cut will have on all the states' economies.

The issue of subcontracting by the major defense contractors was not addressed in this study. However, subcontracting to minor firms,

both inside and outside the state, is a factor that can affect the economic growth of certain areas. Large military construction contracts, such as ship building, require enormous amounts of parts and components which are not produced locally. This effect is linked to the interregional multiplier, and is difficult to quantify.

Military procurement spending is expanding in those states which have experienced high growth rates during the past 10 years. The question posed by Muth [Ref. 12] in his article, "Migration: Chicken or Egg?" can also be applied to defense spending. Has military spending caused the migration to the sunbelt states or has migration to the sunbelt states caused military spending patterns to shift? The answer is elusive. But the trend has been that military spending is shifting away from traditional, smokestack industries of the northeastern states.

The high positive correlation between military spending and the other federal expenditures illustrates the positive effects on states experiencing a growth boom. However, based on an analysis of both the export-based model and the regression analysis of the data, it is believed that these effects would be very different if the patterns of defense expenditures were different.

It must be remembered that a minority of states receive disproportionate amounts of defense monies for two reasons: (1) there are several large defense contractors located in a state, and (2) there are one or more large military installations in the state. Since it is

infeasible to relocate military installations, states must be concerned with keeping the defense contractors located within their confines. To do this, they must analyze the elements that keep industries located in their state.

The burden of maintaining high growth in the individual states must be examined as well. Among these are the increased expenditures to improve the highway systems and higher taxes to finance the building of schools and other public facilities to support the increased growth. The costs and benefits are immense and must be carefully weighed by each state.

In conclusion, defense spending is intertwined throughout the economy of the United States. The impact is substantial and difficult to quantify, even on the simplest level of analysis. The economic growth of the states is linked to the level of defense expenditures, even if these expenditures are for the maintenance of minor military installations. Should defense spending ever be cut, the effects have ramifications for every state. It is these effects that should be studied carefully in any analysis of defense spending and regional growth.

Areas for further investigation beyond the scope of this thesis are suggested as follows:

1. A multiple equation econometric model should be estimated that addresses net migration, employment growth, government expenditures, and capital investment, and their interrelationship with defense expenditures.
2. An analysis should be undertaken of the effects of defense spending and the burdens placed on areas experiencing high growth due to an influx of defense dollars.

3. A model should be developed to predict the effects on employment, industry location, and population caused by cutbacks in defense spending.

REFERENCES

1. Wiedenbaum, Murray L., The Economics of Peacetime Defense, pp. 1-56, Praeger Press, 1974.

2. Bolton, Roger E., Defense Purchase and Regional Growth, pp. 1-174, The Brookings Institution, 1966.

3. Bolton, Roger E., "Regional Econometric Models," Journal of Regional Science Vol. 25, pp. 495-517, November 1985.

4. Isard, Walter, Methods of Regional Science: An Introduction to Regional Science, pp. 124-176, John Wiley and Sons, Inc., 1960.

5. Office of the Secretary of Defense (Comptroller), National Defense Budget Estimates for FY 86, p. 46, Government Printing Office, Washington, D.C., 1985.

6. Richardson, Harry W., Regional Growth Theory, pp. 15-57, John Wiley and Sons, Inc., 1973.

7. Adams, F. Gerhard and Norman J. Glickman, eds., Modeling the Multiregional Economic System, pp. 108-158, Lexington Books, 1980.

8. Riew, John, "Migration and Public Policy," Journal of Regional Science Vol. 13, pp. 65-76, April 1973

9. Pidot, G. Jr., "Principal Growth Components Analysis of the Determinants of Local Government Fiscal Patterns," Review of Economics and Statistics Vol. 51, pp. 176-188, May 1969.

10. Wilensky, G., "Determinants of Local Government Expenditures," Urban Affairs Annual Review Vol. 4, pp. 197-218, December 1978.

11. Romans, Thomas and Ganti Subrahmanyam, "State and Local Taxes and Expenditures and State Industrial Growth," Southern Economic Journal Vol. 46, pp. 435-444, October 1979.

12. Muth, R. F., "Migration: Chicken or Egg?" Southern Economic Journal Vol. 37, pp. 295-306, January 1971.

13. Carroll, Thomas M., "Right to Work Laws Do Matter," Southern Economic Journal Vol. 50, pp. 495-498, October 1983.

14. Plaut, Thomas R. and Joseph E. Pluta, "Business Climate and Industrial Growth," Southern Economic Journal Vol. 51, pp. 99-119, July 1983.

15. Intrilgator, Micheal D., Econometric Models, Techniques and Applications, pp. 150-156, Prentice-Hall Inc., 1978.

16. Helms, L Jay, "The Effect of State and Local Taxes on Economic Growth: A Time Series-Cross Section Approach," The Review of Economics and Statistics Vol. 67, pp. 574-582, November 1985.

APPENDIX

COMPUTER OUTPUT: VARIABLE LIST

D = Population Density
M = Military Spending
E = Federal Education Spending
H = Federal Highway Spending
SE = State Education Spending
SH = State Highway Spending
WG = Manufacturing Wage Rate
TX = Tax Rate Proxy
Y1 = 1976
Y2 = 1977
Y3 = 1978
Y4 = 1979
Y5 = 1979
Y6 = 1980
SC2 = Arizona
SC3 = Arkansas
SC4 = California
SC5 = Colorado
SC6 = Connecticut
SC7 = Delaware
SC8 = Florida
SC9 = Georgia
SC10 = Idaho
SC12 = Illinois
SC13 = Indiana
SC14 = Iowa
SC15 = Kansas
SC16 = Kentucky
SC17 = Louisiana
SC18 = Maine
SC19 = Maryland
SC20 = Massachusetts
SC21 = Michigan
SC22 = Minnesota
SC23 = Mississippi
SC24 = Missouri
SC25 = Montana
SC26 = Nebraska
SC27 = Nevada
SC28 = New Hampshire
SC29 = New Jersey
SC30 = New Mexico
SC31 = New York
SC32 = North Carolina
SC33 = North Dakota
SC34 = Ohio
SC35 = Oklahoma
SC36 = Oregon
SC37 = Pennsylvania
SC38 = Rhode Island
SC39 = South Carolina
SC40 = South Dakota
SC41 = Tennessee
SC42 = Texas
SC43 = Utah
SC44 = Vermont
SC45 = Virginia
SC46 = West Virginia
SC47 = Wisconsin
SC48 = Wyoming
RTW = Right to Work

APPENDIX

COMPUTER OUTPUT: MODEL DATA

DEP VARIABLE: T

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	8	360664378933	45083047367	776.015	0.0001
ERROR	327	18997247907	58095559.35		
C TOTAL	335	379661626840			

ROOT MSE	7622.044	R-SQUARE	0.9500
DEP MEAN	29878.98	ADJ R-SQ	0.9487
C.V.	25.50972		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|
INTERCEP	1	-21494.87868	3591.79460	-5.984	0.0001
D	1	16.68049995	2.08184146	8.012	0.0001
M	1	3.80541531	0.42021504	9.056	0.0001
E	1	124.10785	8.31935742	14.918	0.0001
H	1	27.65777103	11.08052529	2.496	0.0130
SE	1	21.03159168	4.96416728	4.237	0.0001
SH	1	3.84832434	3.54920283	1.084	0.2790
WG	1	1.05818996	0.23186316	4.564	0.0001
TX	1	281.52258	285.70546	0.985	0.3252

Where;
T = State Total Personal Income
D = Population Density
M = Military Spending
E = Federal Education Expenditures
H = Federal Highway Expenditures
SE = State Education Expenditures
SH = State Highway Expenditures
WG = Average Manufacturing Wage Rate
TX = Tax Rate Proxy

DEP VARIABLE: T

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	15	661407877847	44093853523	776.893	0.0001
ERROR	321	18218882048	56756641.89		
U TOTAL	336	679626759894			

ROOT MSE	7533.7	R-SQUARE	0.9732
DEP MEAN	29878.98	ADJ R-SQ	0.9719
C.V.	25.21405		

NOTE: NO INTERCEPT TERM IS USED. R-SQUARE IS REDEFINED.

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|
D	1	14.14080800	2.13146310	6.634	0.0001
M	1	3.43810880	0.43476613	7.908	0.0001
E	1	127.57464	8.42139950	15.149	0.0001
H	1	20.64919500	11.29395768	1.828	0.0684
SE	1	21.39370267	5.08427889	4.208	0.0001
SH	1	7.57852564	4.01393671	1.888	0.0599
WG	1	0.03528069	0.19990068	0.176	0.8600
TX	1	-432.31372	229.58365	-1.883	0.0606
Y1	1	-743.66398	1543.13203	-0.482	0.6302
Y2	1	1488.01761	1568.07338	0.949	0.3434
Y3	1	2271.01011	1530.55991	1.484	0.1388
Y4	1	-1592.35304	1549.34962	-1.028	0.3048
Y5	1	1264.62682	1589.66059	0.796	0.4269
Y6	1	3904.34949	1598.35093	2.443	0.0151
RTW	1	-5322.01707	879.71084	-6.050	0.0001

Where;
T = State Total Personal Income
D = Population Density
M = Military Spending
E = Federal Education Expenditures
H = Federal Highway Expenditures
SE = State Education Expenditures
SH = State Highway Expenditures
WG = Average Manufacturing Wage Rate
TX = Tax Rate Proxy
Y1-Y6 = Year Effect Dummies

DEP VARIABLE: T

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	62	678831161490	10948889701	3770.741	0.0001
ERROR	274	795598404	2903643.81		
U TOTAL	336	679626759894			

ROOT MSE	1704.008	R-SQUARE	0.9988
DEP MEAN	29878.98	ADJ R-SQ	0.9986
C.V.	5.703033		

NOTE: NO INTERCEPT TERM IS USED. R-SQUARE IS REDEFINED.

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|
D	1	320.11427	39.79443675	8.044	0.0001
M	1	3.54783108	0.23574826	15.049	0.0001
E	1	-16.00968765	4.20907806	-3.804	0.0002
H	1	-5.39444737	3.62191143	-1.489	0.1375
SE	1	7.30203512	1.70436013	4.284	0.0001
SH	1	3.52715662	1.16509578	3.027	0.0027
WG	1	-0.05344695	0.39210625	-0.136	0.8917
TX	1	-92.70272103	131.76595	-0.704	0.4823
Y1	1	1384.69522	403.93741	3.428	0.0007
Y2	1	2595.19496	502.36775	5.166	0.0001
Y3	1	2024.73847	383.03004	5.286	0.0001
Y4	1	521.04075	407.26651	1.279	0.2019
Y5	1	295.08276	432.62620	0.682	0.4958
Y6	1	799.76208	486.01736	1.646	0.1010
SC2	1	10388.13123	2511.22378	4.137	0.0001
SC3	1	2243.46233	1656.07385	1.355	0.1766
SC4	1	97245.89040	8568.67214	11.349	0.0001
SC5	1	10085.91953	5734.70425	1.759	0.0797
SC6	1	-181995.18	25076.87929	-7.257	0.0001
SC7	1	-88094.66719	13548.64496	-6.502	0.0001
SC8	1	6577.47220	3478.74827	1.891	0.0597
SC9	1	3666.02413	1188.08358	3.086	0.0022
SC10	1	15783.09596	9949.78359	1.586	0.1138
SC11	1	1931.25291	5129.81332	0.376	0.7069
SC12	1	-18126.38318	8258.28221	-2.195	0.0290
SC13	1	6052.84380	1788.43783	3.384	0.0008
SC14	1	9147.60658	2220.71617	4.119	0.0001
SC15	1	-9655.32980	6283.97037	-1.537	0.1256
SC16	1	-1871.09109	1738.48937	-1.076	0.2828
SC17	1	-4775.87962	4686.20807	-1.019	0.3090
SC18	1	-103231.05	16830.71950	-6.133	0.0001
SC19	1	-189343.43	27934.79348	-6.778	0.0001
SC20	1	10371.08937	9477.53915	1.094	0.2748
SC21	1	9457.70923	6018.68649	1.571	0.1172
SC22	1	-2240.11333	1398.28268	-1.602	0.1103
SC23	1	163.25945	5907.74546	0.028	0.9780
SC24	1	3394.18836	5631.57141	0.603	0.5472
SC25	1	7666.81493	2397.85429	3.197	0.0015
SC26	1	7943.62450	2938.83967	2.703	0.0073
SC27	1	-25787.76325	5925.62904	-4.352	0.0001
SC28	1	-250845.74	38004.27565	-6.600	0.0001
SC29	1	3624.21517	4466.74308	0.811	0.4179
SC30	1	548.02966	15372.48969	0.036	0.9716

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|
SC31	1	459.09352	1830.80199	0.251	0.8022
SC32	1	5590.89550	2755.00374	2.029	0.0434
SC33	1	-18972.22131	11837.76375	-1.603	0.1102
SC34	1	3683.97541	5418.66967	0.680	0.4972
SC35	1	8364.30528	5859.03729	1.428	0.1545
SC36	1	-11109.77587	11700.30534	-0.950	0.3432
SC37	1	-244700.18	31566.22132	-7.752	0.0001
SC38	1	-11597.71233	1479.97991	-7.836	0.0001
SC39	1	5735.82506	2764.08403	2.075	0.0389
SC40	1	-6678.47038	1615.45919	-4.134	0.0001
SC41	1	64197.30797	2497.53241	25.704	0.0001
SC42	1	6270.74891	2521.91542	2.487	0.0135
SC43	1	-13438.19219	5460.98303	-2.461	0.0142
SC44	1	-2106.65401	1545.52655	-1.363	0.1740
SC45	1	4266.80361	6776.61866	0.630	0.5295
SC46	1	-14570.24267	6665.88216	-2.186	0.0297
SC47	1	3093.84871	6567.28919	0.471	0.6379
SC48	1	2197.79579	5834.88603	0.377	0.7067
RTW	1	-4382.73302	5399.93525	-0.812	0.4177

Where;
T = State Total Personal Income
D = Population Density
M = Military Spending
E = Federal Education Expenditures
H = Federal Highway Expenditures
SE = State Education Expenditures
SH = State Highway Expanditures
WG = Average Manufacturing Wage Rate
TX = Tax Rate Proxy
Y1-Y6 = Year Effect Dummies
SC2-SC48 = State Effect Dummies

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93943-5002	2
3.	Professor Loren M. Solnick, Code 54 Sb Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5004	1
4.	Professor Stephen L. Mehay, Code 54Mp Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5004	1
5.	LT Brian G. Finch Surface Warfare Officers School Command Naval Education and Training Center Newport, Rhode Island 02841-5000	2

Thesis
F4322 Finch
c.1 Defense spending and regional growth: an examination of an export-base model and on econometric model.